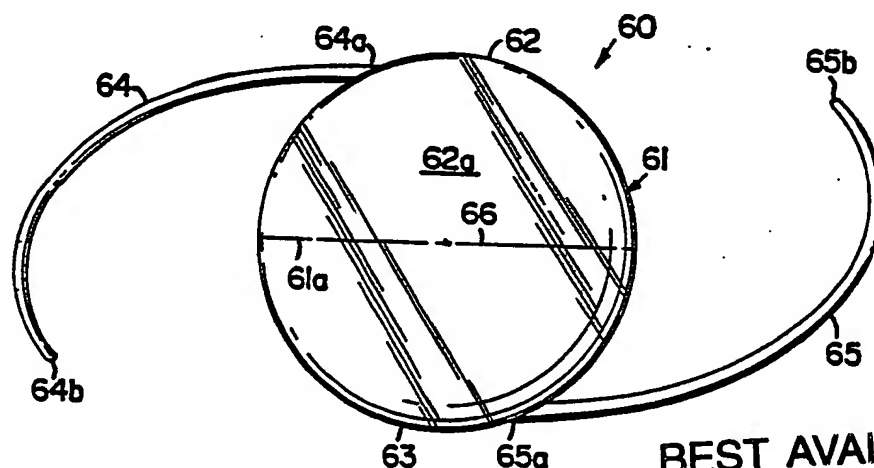


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(54) Title: ONE-PIECE BIFOCAL INTRAOCULAR LENS CONSTRUCTION



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(57) Abstract

A rigid bifocal intraocular lens (60) for use as an artificial lens implant. In one embodiment, the intraocular lens has a rigid lens body (61) having a chord (61a) and first and second lens portions (62) and (63). The first lens portion (61) has a focal length and the second lens portion (63) has a focal length different from the focal length of the first lens portion (62). The first lens portion (62) is positioned on one side of the chord (61a) and the second lens portion (63) is positioned on the other side of the chord (61a). The first and second lens portions (62 and 63) form an integral, one-piece optical lens body (61) with the first and second lens portions being non-movable with respect to one another. In another embodiment the rigid lens body has a first central circular lens portion and a second outer annular lens portion. In a preferred form of this embodiment the inner, circular lens has a diameter of a between about 1.8 millimeters and bout 2.2 millimeters, with the outer annular lens portion having a diameter of between about 6 millimeters and 7 millimeters. A preferred corrective power for the lenses used in the above-referenced embodiments is between about +15 and about +25 diopters for a distance-viewing lens portion, and a corrective power for a near-viewing portion of between about +2 and +4 diopters gra-

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ONE-PIECE BIFOCAL INTRAOCULAR
LENS CONSTRUCTION

Related Applications

This application claims priority from U.S. 871,077 filed June 5, 1986 and U.S. 015,878 filed February 18, 1987.

5

Field of the Invention

10 This invention relates generally to intraocular lenses to be used as artificial lens implants in eyes from which the cataractous natural lens has been removed, and more particularly to an improved rigid lens having multiple lenses.

15

Description of the Prior Art

20 The implantation of an intraocular lens for restoring vision after cataract surgery is well-known in the art. In general, two forms of surgery are used to remove cataracts. These are extracapsular cataract extraction and intracapsular extraction. (Discussed in U. S. Pat. Re. 31,626 to Hoffer.) Following extraction of a cataractous lens, an intraocular lens is normally
25 implanted in either the anterior or the posterior chamber of the eye. In an anterior chamber implant, the lens is generally situated forward of, or mounted to, the iris. In the case of posterior chamber implants, the lens is situated behind the iris and may be mounted

within the cleft or fornix of the capsule which remains in place after extracapsular surgery.

In both anterior or posterior chamber implants, the lens is usually centered and fixed in position by one or more supporting strands or haptic members. While available intraocular lenses incorporate haptic member(s) having various geometric shapes and configurations, the typical haptic member is a flexible strand of non-biodegradable material which is fixed to the lens body, and exhibits specific spring-like memory qualities so that the haptic member can be compressed or off-set from the normal rest position and thereafter returned to the fully extended condition when pressure is removed.

The intraocular implant is an artificial lens which has one given focal length. Since the intraocular implant is made of a rigid material it cannot change the focal length by deformation as the natural lens does (called accommodation). As a result of this, if the focal length is selected to provide a sharp image for a distant object, then an object which is closer (i.e. at reading distance) will not be imaged sharply on the retina. Alternately, one could image closer objects sharp by selecting a different focal length, but then, of course, distant objects would appear out of focus.

Contact lenses have been made having multi-focal length and also having variable light absorption. U. S. Patent No. 3,270,099 issued August 30, 1966 to R.N. Camp discloses a method for making a multi-focal length contact lens. The Camp patent deals with a contact lens which is not used for the same function or manner as an intraocular lens. Further, the Camp

patent teaches that the eye uses the inner part of the cornea for near vision while the outer part is used for distant vision. For this reason, the Camp contact lens covers the cornea with a contact lens which has one power in the inner part and another power in the outer part. As a basis for such a lens, the Camp patent teaches that the divergent rays which enter the peripheral portion are not focused on the retina and hence are unseen. This is, of course, a violation of the laws of physics as light is detected by the retina regardless of whether it is focused or unfocused.

U. S. Patent No. 3,034,403 to Neefe was issued May 15, 1962 and discloses a contact lens of apparent variable light absorption. The center portion of the contact lens is tinted while the outer portion is clear.

The present invention addresses the problems associated with the prior art intraocular lenses in that they have not provided for a rigid multi-focal length lens. The present invention provides for such a multi-focal length intraocular lens.

Summary of the Invention

The present invention is a rigid bifocal intraocular lens adapted for uses in artificial lens implant. A single rigid implant is provided having one or more additional lenses ground into it, so as to function like bifocal glasses. In the preferred embodiment a plurality of lens portions are formed in the intraocular lens and each lens

portion is substantially non-movable with respect to the other(s).

The intraocular lens of the first embodiment has an optical lens body with a central, circular, lens portion and an outer, annular, lens portion. The
5 central, or first, lens portion has a focal length and the second, or outer, annular lens portion has a focal length different from the focal length of the first lens portion. The relative areas of the two lens portions may vary, and in the first embodiment described
10 the two are about the same size. However, preferably the diameter of the outer annulus is about 6-7 millimeters, whereas the overall diameter of the inner circular lens portion is between about 1.8 and about 2.2
15 millimeters.

The relative corrective powers of the lens portions may also vary; however, preferably, the corrective factor of the outer (annular) lens portion is between about +5 and +25 diopters, whereas the
20 corrective power of the inner portion is between about +2 and +4 diopters larger than the power of the annular portion. That is, the inner portion preferably has a corrective or add factor of between about +2 and +4 diopters with respect to the outer portion. The first
25 and second lens portions form an integral, one-piece, bifocal optical lens body.

The intraocular lens of an alternate embodiment has an optical lens body having a chord and first and second lens portions. The first lens portion has a
30 focal length and the second lens portion has a focal length different from the focal length of the first lens portion. The first lens portion is positioned on one side of the chord and the second lens portion is

positioned on the other side of the chord. The first and second lens portions form an integral, one-piece bifocal optical lens body wherein the first and second lens portions are substantially non-movable with respect to one another. Preferably, for the alternate embodiment the lens body is substantially circular and the chord is a diameter of the lens body.

For best results, the images from both lens portions for either embodiment should end up in the same plane. That is, the powers of the two lens portions should be selected so that the image from infinity projected through the second lens portion will be focused in about the same plane as the image from a close object being located at standard reading distance projected through the first lens portion. As a result of this construction, when a user wearing the intraocular implant uses same to view, both of the first and second lens portions may produce images substantially superimposed on one another. Depending on the distance to the object(s) being viewed and the amount of light present, one of the images will appear sharp and the other sufficiently defocused to permit the user's brain to select the sharper image for evaluation.

Brief Description of the Drawings

Figure 1 is a cross-sectional view of the eye and shows a lens incorporating our present invention implanted in the posterior chamber of the eye.

Figure 2 is a top plan view of the lens of Figure 1, shown according to a first embodiment of the invention.

Figure 2A is generally the same as Figure 2, except Figure 2A is reduced, is fragmentary, and shows different relative sizes between various lens portions.

Figure 3 is a side elevational view of the lens shown in Figure 1.

Figure 4 is a top plan view of a second embodiment of the present invention.

Figure 5 is a side elevational view of the lens shown in Figure 4.

Figure 6 is a cross-sectional view, taken along the line 6-6 of Figure 4.

Figure 7 is a cross-sectional view of the eye and shows a lens incorporating an embodiment of our present invention implanted in the posterior chamber of the eye; the lens being a plano-convex variation of the embodiment shown in Figure 1.

Figure 8 is a top plan view of the lens of Figure 7.

Figure 8A is generally the same as Figure 8, except Figure 8A is reduced, is fragmentary, and shows different relative sizes between the various lens portions.

Detailed Description of the Invention

Referring to the drawings, wherein like numerals represent like parts throughout the several views, an intraocular lens, designated generally as 10, is shown in Figures 1 through 3, with Fig. 2A showing a variation described below. The intraocular lens 10 includes a rigid optical region or lens body 11 which

includes a first lens portion or lens 12 cooperatively connected to a second lens portion or lens 13 to form a lens body or optical region 13.

5 In a preferred embodiment the first lens 12 is an inner lens having an axis 12a. The second lens 13 is an annular lens having an axis 13a. The lens body 11, or optic portion of the intraocular lens 10, is centered and retained within the eye by retaining means such as haptic members 14 and 15 having first ends 14a and 15a and second ends 14b and 15b respectively. The first ends 14a and 15a are cooperatively connected to the lens body 11 by methods well known in the art. Further, the construction and specific configuration of the haptic members 14 and 15 may be any suitable construction, such construction being well known in the art.

15 In a preferred embodiment, the haptic members 14 and 15, inner lens 12 and annular lens 13 are formed as an integral one-piece structure by a forging and machining process. However, it will be appreciated that the intraocular lens 10 may also be produced by other suitable methods such as injection molding and lathing. As a result the inner lens 12 and annular lens 13 are substantially non-movable with respect to one another.

20 The unitary intraocular lens body 11, including the first lens 12 and second lens 13, is made of a biological tolerable and optically suitable material such as polymethylmethacrylate (PMMA). The haptic members 14 and 15 may be made of a flexible, compressible, resilient plastic material such as PMMA or polypropylene, or other materials as well known in the art. Preferably, the entire intraocular lens 10 is of an integral one-piece structure and is made of PMMA.

The posterior chamber type intraocular lens 10 will typically be utilized following extra capsular cataract extraction. As illustrated in Figure 1, the lens 10 is implanted in a human eye 40, in the posterior chamber 42 behind the iris 44. Preferably, the cataract has been extracted from the capsular bag 46, leaving intact the posterior wall 46a and an annular flap portion 46b forming a cleft of fornix 46c. The capsular bag 46 is connected to the ciliary muscle in the eye wall 48 via suspensory ligaments 50. Vitreous humor in the region 52 behind the capsular bag 46 is prevented from flowing forward by the posterior wall 46a. It is, of course, understood that the present invention may also be used in the anterior chamber of the eye 40.

The intraocular lens 10 may serve as a bifocal vision system, with one lens 12 for reading and the other lens 13 for distant viewing. As shown in the preferred embodiment, the axis 12a of the inner lens 12 is coaxial with the axis 13a of the annular lens 13. However, it is understood that the certain principles of the present invention will also be applicable where the axes 12a and 13a are not coaxial.

Prior art methods of providing bifocal vision systems, such as bifocal glasses, are exclusive; meaning one can either read or look in the distance. Generally, there is a blurred region in between, which is awkward. With the present application this would not be the case. The first lens portion has a focal length that is for viewing near objects and the second lens portion has a focal length that is for viewing distant objects. Such a combination of lenses will produce two images on the retina which are superimposed. Always, one of the two images will appear

blurred. If an object up close is viewed, the image produced through the second lens will appear blurred; or, if the object is viewed at a distance, the image through the first lens will appear blurred. The user's brain can select the sharper image for evaluation.

In a preferred embodiment, as shown in the figures, the first lens 12 is a center lens having a focal length for reading and the second lens 13 is an annular ring shaped lens having a focal length for distant viewing. The area of each lens 12 and 13 will ideally be computed individually for each patient, depending upon the patient's iris reflexes, as described more fully hereafter. In actual practice, a whole series of lenses would probably be provided, having different corrective properties, so that an appropriate lens could be selected for any given patient.

In the parent case, it was indicated that preferably the area of the first lens 12 would be from approximately 30% to 50% of the area of the lens body 11. Further, it was indicated as preferred that the first lens 12 be approximately 40% of the total area of the lens body 11 or, otherwise stated, the area of the first lens 12 be approximately equal to the area of the second lens 13. This is shown in Fig. 2.

A preferred arrangement outside of the above-stated range has been found. Fig. 2A shows an arrangement which is substantially identical to Fig. 2 in substance, but for the relative sizes of the lens portions 12' and 13', to indicate the alternate and preferred possibility. For this arrangement, it will generally be preferred that the annular portion have a diameter of about 6.0 to about 7.0 millimeters while the inner portion has a diameter of about 1.8 to about 2.2

millimeters. Thus, the area of the first lens portion is between about 6% and 14% of the combined areas of the first and second lens portions. In Fig. 2A reference numerals 10', 11', 12', 13', 14', 14a', 15' and 15a' indicate parts generally analogous, in form and function, to parts 10, 11, 12, 13, 14, 14a, 15, and 15a respectively.

It is also foreseen that the desired relative powers between the two lens portions may vary from patient to patient. Generally, for most uses an operable embodiment will have a corrective power of about +15 to about +25 diopters, for the outer lens portion, the portion used for distance viewing; and, a corrective power of about +2 to about +4 diopters larger than the outer lens portion for the inner portion, i.e. that portion used for near viewing.

If a distant object is viewed in moderately bright illumination, the iris 44 will be open and the image created by the annular lens 13 (which is sharp) will overpower the blurred and also less bright image created by the inner lens 12. The overpowering process is made possible by the fact that blurred edges are less intense than sharp edges, and by the way the image evaluation system of the brain works.

Reading takes place usually indoors and bright illumination can readily be applied. The iris 44 will close, and the area of the annular lens 13 will be reduced so that the image of the inner lens 12 (which is now sharp) will overpower the blurred, less bright, image generated by the annular lens 13. Therefore, by the management of the intensity of the images, as is accomplished in the present invention, there can be two superimposed images one of which is blurred and one of

which is sharp. The brain's evaluation system will accordingly see the sharp image. The image evaluation system of the brain searches for sharp edges and, once it finds a sharp edge, it exaggerates the edge.

5 Therefore, generally, as long as the blurred image is weaker in intensity than the sharp one, the brain will evaluate the images and "see" the sharp image.

10 It is understood that any suitable combination such as plano-convex, biconcave, meniscus or other combination of lenses may be used with either an add on center or a distance on center to provide for the inner lens 12. It is only necessary for one skilled in the art to make a suitable combination of such lenses to provide for a focal length for one of the lenses 12 or 15 13 for distance reading and a focal length for the other of the lenses 12 or 13 having a focal length for viewing near objects, preferably with both of the lenses having a positive power.

20 Another embodiment of the present invention is shown in Figures 4-6. This lens would also be positioned in the eye as shown in Figure 1. The second embodiment of the implantable intraocular lens 60 includes a rigid bifocal optical region or lens body 61 which includes a first lens portion 62 and a second lens portion 63, the bases of which are coplanar. The lens body 25 61 has a chord 61a between lens portions 62 and 63. This embodiment is also adapted to be implanted in the posterior chamber, although the concept can be utilized in an anterior chamber lens as well.

30 Preferably, the unitary optical lens body 61 is substantially circular, the chord 61a is a diameter of the lens body 61 and the lens portions are semicircular. Thus, for this embodiment the first and second

lens portions may preferably be of about the same size and the lens portions are substantially non-movable with respect to one another. The powers for the near vision and distance vision sections may be as previously described for the first embodiment, although other powers may be selected, depending upon the specific applications intended.

The lens body 61, or optic portion of the intraocular lens 60, is centered and retained within the eye by retaining means such as haptic members 64 and 65 having first ends 64a and 65a and second ends 64b and 65b, respectively. The first ends 64a and 65a are cooperatively connected to the lens body 61 by methods well known in the art. Further, the construction of a specific configuration of the haptic members 64 and 65 may be any suitable construction, such construction being well known in the art.

Preferably, the haptic members 64 and 65, the first lens 62 and second lens 63 are molded as an integral one-piece structure. However, it will be appreciated that the intraocular lens 60 may also be produced by other suitable methods such as forging and machining. The unitary intraocular lens body 61, including the first lens 62 and second lens 63, is made of a biological tolerable and optically suitable material such as PMMA. The haptic members 64 and 65 may be made of a flexible, compressible, resilient plastic material such as PMMA or polypropylene, or other materials as well known in the art. Preferably, the entire intraocular lens 60 is made of an integral one-piece structure and also is made of PMMA. The intraocular lens 60 may serve as a bifocal vision system, with one lens 62 for reading and the other lens 63 for distant

viewing.

As previously discussed, prior art methods of providing bifocal vision systems, such as bifocal glasses are exclusive. With the present embodiment this would not be the case. One of the lens portions would have a focal length that is for viewing near objects and the other of the lens portions would have a focal length different from the first lens portion and that is for viewing distant objects. Such a combination of lenses will produce two images on the retina which are superimposed. Always, one of the two images will appear blurred. The eye is constantly scanning the images created on the retina and selectively chooses the image (the sharp one) to see. By having an intraocular lens 60 that is equally split, with the chord 60a being a horizontal diameter, the iris of the eye will always be in position in front of both lens portions 62 and 63 and therefore the retina will always have an image formed on it from both the lens portions 62 and 63. The area of the first lens portion 62 is preferably approximately equal to the area of the second lens portion 63.

Again, when the two lens portions are equal, the chord 61a is substantially a diameter of the lens body 61. However, the chord 61a could be offset from the center without departing from the invention.

As is clearly shown in Figure 6, the lens body 61 has a planar bottom surface 61b that extends across both the first lens portion 62 and second lens portion 63. The first lens portion 62 has an upper convex surface 62a and the second lens portion 63 has an upper convex surface 63a, the latter one having a different radius of curvature than the first. Reference numeral 66 generally indicates a transition region between the

two lens portions which for the preferred embodiment shown, is chord 61a. In Figure 6 plane 67 represents a division of the lens 61 into its two halves 62 and 63 of different powers. While different radii of cur-
5 vatures are drawn, the difference is small and hard to see. It will nevertheless be understood to be present.

Figure 7 is a cross-sectional view of a lens incorporating the present invention taken from a point of view generally analogous to the use for Figure 1,
10 but showing an alternate thereto. In particular, the lens body of Figure 7 is shown having a plano-convex structure. That is, it is generally planar on one side and convex on the other. This arrangement may be advantageous, in that it is potentially easier to
15 construct. For the arrangement shown in Figure 7, the reference numeral 100 generally designates the eye, and the reference numeral 111 the lens. The arrangement will be understood to be analogous to that shown in Figures 1-3, but for the utilization for a plano-convex
20 structure for the lens. The near vision portion 112 of the lens may be, for example, of the relative diameter to the distant vision portion 113, as previously described for Figures 1-3. In the alternative, that
25 ratio of areas described previously for Figure 2A, may also, preferably, be used. Desirable corrective factors for the two portions may be as previously indicated. That is, preferably, with the distance portion having a corrective power of between about +15 and +25 diopters, with the corrective power of the inner, near
30 vision, lens portion having an add power of between about +2 and about +4 diopters.

In Figure 8 a top plan view of the lens of Figure 7 is shown. Again, except for the plano-convex

structure, the arrangement is analogous to that shown in Figure 2.

Finally, in Figure 8A an alternate to the arrangement shown in Figure 7 and 8 is shown, wherein the inner lens portion 112' is constructed smaller, with respect to the outer lens portion 113'. Specifically, for this arrangement it will generally be preferred that the annular portion have a diameter of about 6.0 to about 7.0 millimeters, while the inner portion has a diameter of about 1.8 to about 2.2 millimeters. Thus, the arrangement is generally analogous to that shown in Figure 2A, but for the plano-convex structure.

Although the preferred embodiment of the invention is a bifocal lens, it should be understood that one or more additional lenses may be incorporated to correct for different distances.

Other modifications of the invention will be apparent to those skilled in the art in light of the foregoing description. This description is intended to provide specific examples of individual embodiments which clearly disclose the present invention. Accordingly, the invention is not limited to these embodiments or to the use of elements having specific configurations and shapes as presented herein. All alternative modifications and variations of the present invention which follow in the spirit and broad scope of the appended claims are included.

We claim:

1. A rigid intraocular lens adapted for use as an artificial lens implant, said intraocular lens comprising:

(a) means for non-movably retaining said lens implant within a chamber of a user's eye; and,

(b) a lens body including a first lens portion and a second lens portion;

(i) said first lens portion having a focal length and being non-movably mounted in said intraocular lens;

(ii) said second lens portion being non-movably mounted in said intraocular lens and having a focal length different from said focal length of said first lens; said second lens portion being in cooperative engagement with said first lens portion to form an optical region of said lens body;

(iii) said first lens portion being constructed and arranged for viewing relatively near objects and having an optical power of between about +2 and about +4 diopters greater than said second lens portion;

(iv) said second lens portion being constructed and arranged for viewing relatively distant objects and having an optical power of between about +15 and about +25 diopters;

(v) said first lens portion being constructed and arranged to project focused images created thereby in substantially the same plane as second images projected by said second lens portion;

(c) whereby when a user wearing said intraocular lens uses same to view, both of said first and second lens portions may produce images substantially superimposed upon one another with, depending generally on the distance of the object being viewed and the amount of light present, one of the images appearing sharp and the other image defocused to permit the user's brain to select the sharper image for evaluation.

2. The intraocular lens according to claim 1 wherein:

(a) said first lens portion is circular and has an axis; and,

(b) said second lens portion is annular and has an axis,

(i) said second, annular, lens portion surrounding said first lens portion with said first lens portion axis substantially coaxial with said second lens portion axis.

3. A rigid intraocular lens adapted for use as an

artificial lens implant, said intraocular lens comprising:

- (a) at least one haptic member adapted for substantially non-movably retaining said lens implant within a chamber of a user's eye; and,
- 5 (b) a lens body including a first, central, circular lens portion and a second, outer, annular lens portion;
 - (i) said first lens portion being having a focal length and an axis and being non-movably
10 mounted in said intraocular lens;
 - (ii) said second lens portion being non-movably mounted in said intraocular lens and having a focal length, different from said focal length of said first lens, and an axis;
15 said second lens portion being in cooperative engagement with said first lens portion to form an optical region of said lens body;
 - (iii) said first lens portion axis being substantially coaxial with said second lens portion axis;
20
 - (iv) said first lens portion being constructed and arranged for viewing relatively near objects and said second lens portion being
25 constructed and arranged for viewing relatively distant objects;
 - (v) said first lens portion being constructed and arranged to project images created thereby in substantially the same plane as
30 images projected by said second lens portion;
- (c) whereby when a user wearing said rigid intraocular lens uses same to view, both of said first

and second lens portions may produce images substantially superimposed upon one another with, depending generally on the distance of the object being viewed and the amount of light present, one of the images appearing sharp relative to the other; the user's brain enabling evaluation to selectively see the sharper image.

4. - The intraocular lens of claim 3 wherein both said first lens portion and said second lens portion have a positive power.

5. A rigid intraocular lens adapted for use as an artificial lens implant, said intraocular lens comprising:

- (a) means for substantially non-movably retaining said lens implant within a chamber of a user's eye; and,
- (b) a lens body including a first, central, circular lens portion and a second, outer, annular lens portion;
 - (i) said first lens portion having a focal length and an axis and being nonmovably mounted in said intraocular lens;
 - (ii) said second lens portion being nonmovably mounted in said intraocular lens and having a focal length, different from said focal length of said first lens, and an axis;

said second lens portion being in cooperative engagement with said first lens portion to form an optical region of said lens body;

(iii) said first lens portion axis being substantially coaxial with said second lens portion axis;

(iv) said first lens portion being constructed and arranged for viewing relatively near objects and said second lens portion being constructed and arranged for viewing relatively distant objects;

(v) said first lens portion being constructed and arranged to project images created thereby in substantially the same plane as images projected by said second lens portion;

(c) whereby when a user wearing said rigid intraocular lens uses same to view, both of said first and second lens portions may produce images substantially superimposed upon one another with, depending generally on the distance of an object being viewed and the amount of light present, one of the images appearing sharp relative to the other; the user's brain enabling evaluation to selectively see the sharper image.

6. The intraocular lens of claim 5 wherein both said first lens portion and said second lens portion have a

positive power.

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7. A rigid intraocular lens adapted for use as an artificial lens implant, said intraocular lens comprising:

10

(a) means for substantially non-movably retaining said lens implant within a chamber of a user's eye; and

15

(b) a lens body including a first, central, circular lens portion and a second, outer, annular lens portion;

20

(i) said first lens portion having a focal length and an axis and being non-movably mounted in said intraocular lens;

(ii) said second lens portion being non-movably mounted in said intraocular lens and having a focal length, different from said focal length of said first lens portion, and an axis; said second lens portion being in cooperative engagement with said first lens portion to form an optical region of said lens body;

25

(iii) said first lens portion axis being substantially coaxial with said second lens portion axis;

30

(iv) said first lens portion being constructed and arranged to project images created thereby in substantially the same plane as images projected by said second lens portion;

(c) whereby when a user wearing said intraocular

lens uses same to view, said first lens portion may be selectively used to focus in view objects at a first distance and said second lens portion may be selectively used to focus in view objects at a second distance without accommodation.

8. The intraocular lens of claim 7 wherein both said first lens portion and said second lens portion have a positive power.

9. A rigid intraocular lens adapted for use as an artificial lens implant, said intraocular lens comprising:

(a) means for substantially non-movably retaining said lens implant within a chamber of a user's eye; and,

(b) a lens body including a first lens portion and a second lens portion;

(i) said first lens portion having a focal length and being non-movably mounted in said intraocular lens;

(ii) said second lens portion being non-movably mounted in said intraocular lens and having a focal length different from said focal length of said first lens; said second lens portion being in cooperative engagement with

said first lens portion to form an optical region of said lens body;

(iii) said first lens portion being constructed and arranged for viewing relatively near objects and said second lens portion being constructed and arranged for viewing relatively distant objects;

(iv) said first lens portion being constructed and arranged to project images created thereby in substantially the same plane as images projected by said second lens portion;

(c) whereby when a user wearing said intraocular lens uses same to view, said first lens portion may be selectively used to focus in view relatively near objects and said second lens portion may be selectively used to focus in view relatively far objects, without accommodation.

10. The intraocular lens of claim 9 wherein both said first lens portion and said second lens portion have a positive power.

11. A rigid intraocular lens adapted for use as an artificial lens implant, said intraocular lens comprising:

(a) means for substantially non-movably retaining said lens implant with a chamber of a user's eye; and,

(b) a lens body including a first lens portion and a second lens portion;

(i) said first lens portion having a focal length and being non-movably mounted in said intraocular lens;

(ii) said second lens portion being non-movably mounted in said intraocular lens and having a focal length different from said first lens portion; said second lens portion being in cooperative engagement with said first lens portion to form an optical region of said lens body;

(c) whereby when a user wearing said intraocular lens uses same to view, said first lens portion may be selectively used to focus in view objects at a first distance and said second lens portion may be selectively used to focus in view objects at a second distance.

12. The rigid intraocular lens of claim 11 wherein:

(a) said first and second lens portions are constructed and arranged to project images created thereby in substantially the same plane.

13. The rigid intraocular lens of claim 12 wherein:
- (a) said first lens portion is a first, central, circular lens portion; and
 - (b) said second lens portion is an outer annular lens portion.

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14. The rigid intraocular lens of claim 13 wherein:
- (a) said first and second lens portions are constructed and arranged to project images created thereby in substantially the same plane.

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15. The rigid intraocular lens of claim 14 wherein:
- (a) said first lens portion is constructed and arranged for viewing relatively near objects; and
 - (b) said second lens portion is constructed and arranged for viewing relatively distant objects.

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16. The rigid intraocular lens of claim 15 wherein:
- (a) said first and second lens portions are constructed and arranged to project images created thereby in substantially the same plane.

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17. The intraocular lens of claim 16 wherein both said first lens portion and said second lens portion have a positive power.

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18. A rigid bifocal intraocular lens adapted for use as an artificial lens implant, said intraocular lens comprising:

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- (a) an optical lens body having a chord and first and second lens portions;
- (b) said first lens portion have a focal length;
- (c) said second lens portion having a focal length different from said focal length of said first lens portion;
- (d) said first lens portion positioned on one side of said chord and said second lens portion positioned on the other side of said chord;
- (e) said first and second lens portions forming a unitary optical lens body; and
- (f) haptic elements cooperatively connected to said lens body.

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19. The intraocular lens of claim 18, wherein said lens body is circular and said chord is a diameter of said lens body.

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20. The intraocular lens of claim 18, wherein said first lens portion has a focal length that is for

viewing near objects and said second lens portion has a focal length that is for viewing distant objects, wherein when viewing an object, said portions will each produce an image on the retina, said images being superimposed and, depending on the distance of the object, one of said images will be sharp and the other of said images will be sufficiently blurred, to induce a wearer's brain to evaluate in a manner to allow clean perception of only one sharp image.

21. The intraocular lens of claim 18 wherein:

- (a) said first lens portion has a power of between about +2 and about +4 diopters larger than the second lens portion; and,
- (b) said second lens portion has a power of between about +15 and about +25 diopters.

22. A bifocal intraocular lens adapted for use as an artificial lens implant in the posterior chamber of the eye, said intraocular lens comprising:

- (a) a circular optical lens body having a chord and first and second lens portions;
- (b) said first lens portion having a focal length;
- (c) said second lens portion having a focal length different from said focal length of said first lens portion;
- (d) said first lens portion positioned on one side of said chord and said second lens portion positioned on the other side of said chord;

- (e) said first and second lens portions forming a unitary optical lens body;
- (f) haptic elements cooperatively connected to said lens body for positioning said lens body posterior to the iris of the eye; and
- (g) wherein said first lens portion has a focal length that is for viewing near objects and said second lens portion has a focal length that is for viewing distant objects, wherein when viewing an object, said portions will each produce an image on the retina, said images being superimposed and, depending on the distance of the object, one of said images will be sharp and the other of said images sufficiently blurred, to induce a wearer's brain to evaluate the image in a manner inducing perception of only one, sharp, image.

23. The intraocular lens of claim 22, wherein said lens portions are semicircular and have coplanar bases.

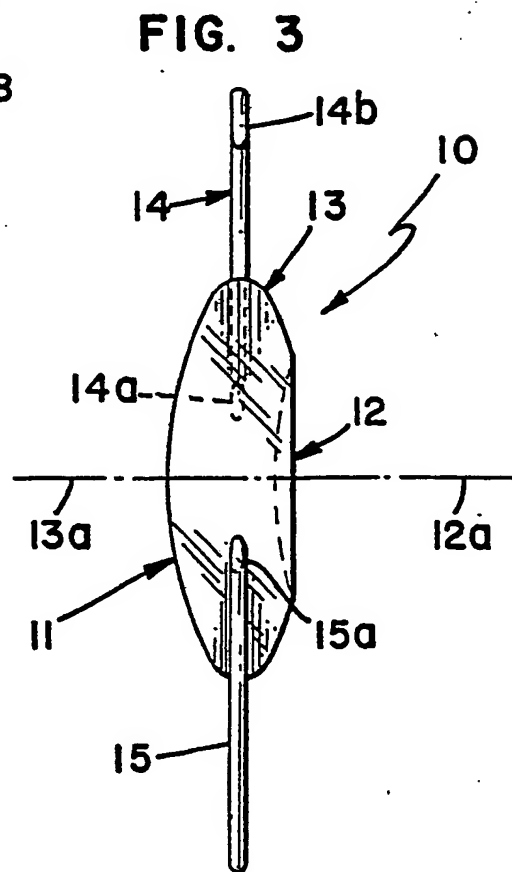
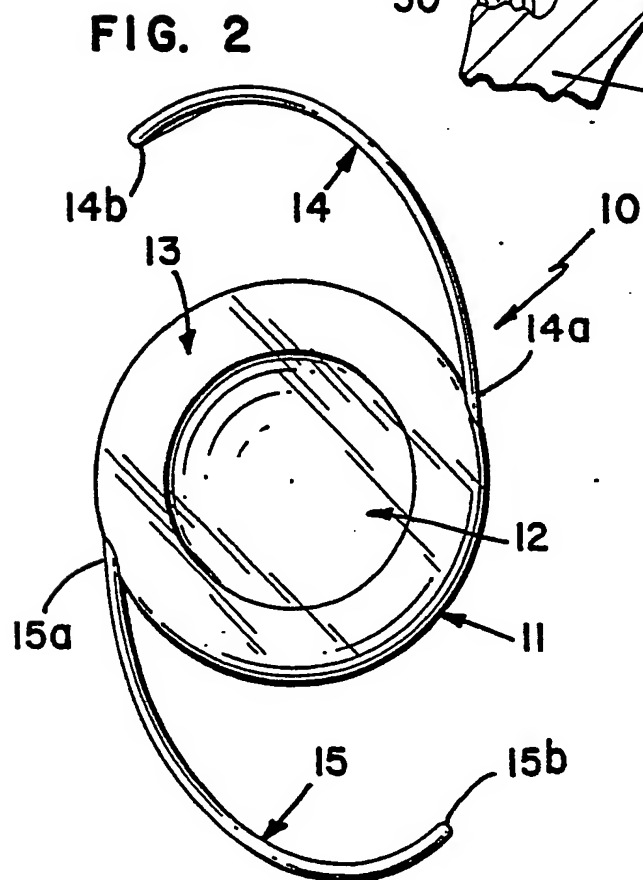
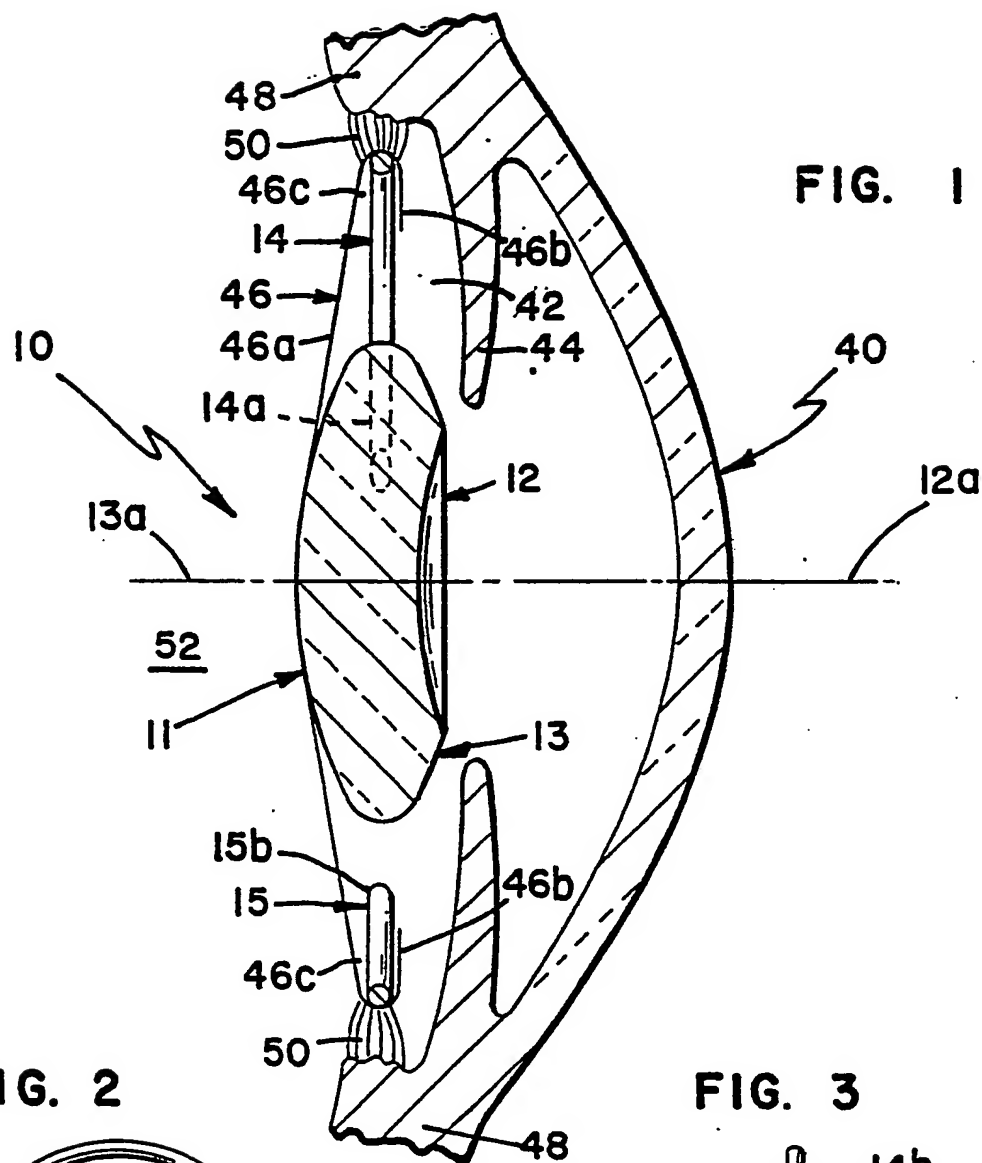


FIG. 4

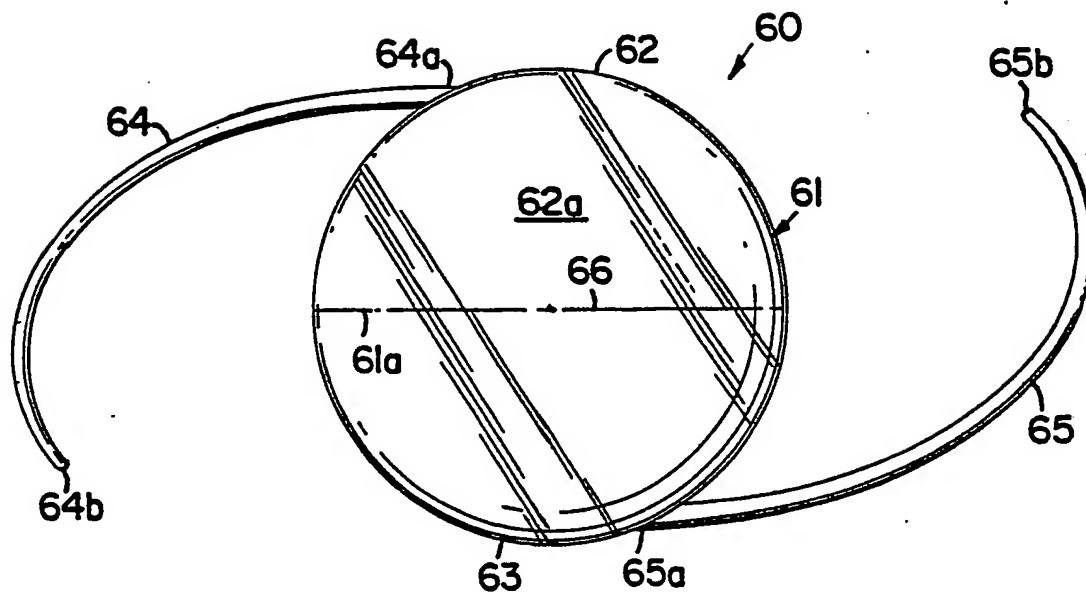


FIG. 5

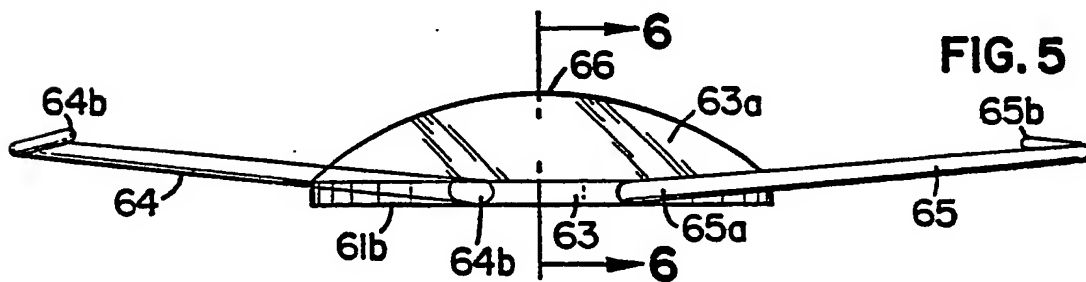


FIG. 6

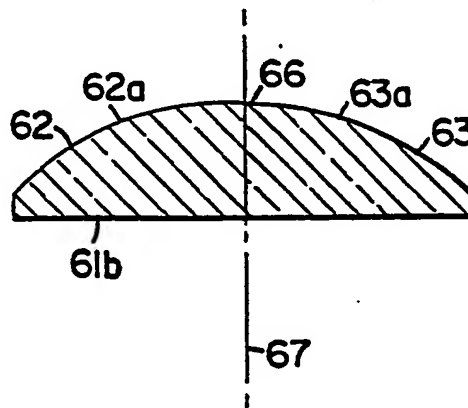


FIG.7

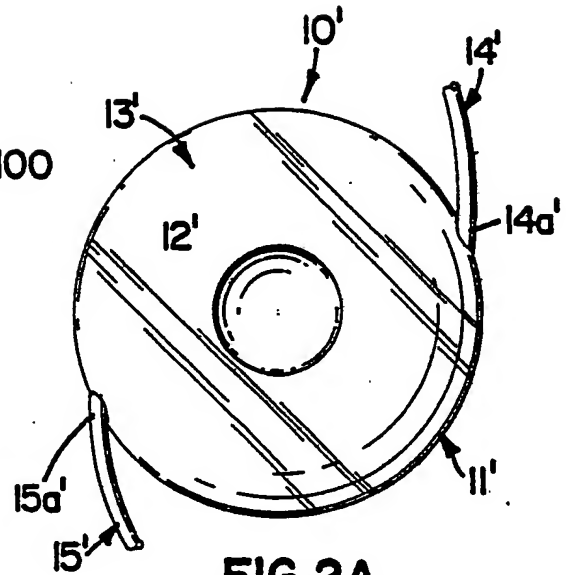
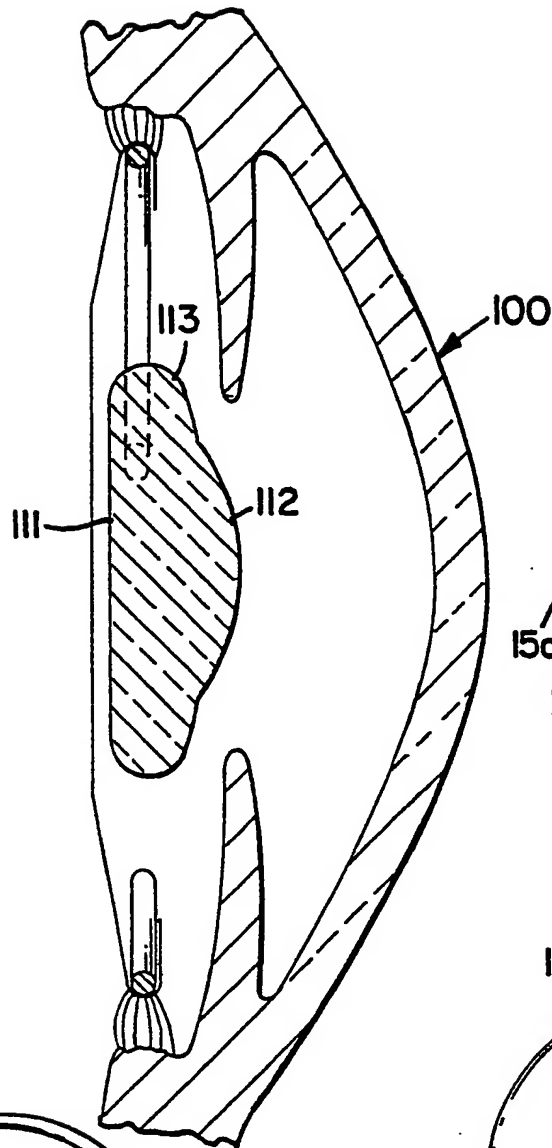


FIG.2A

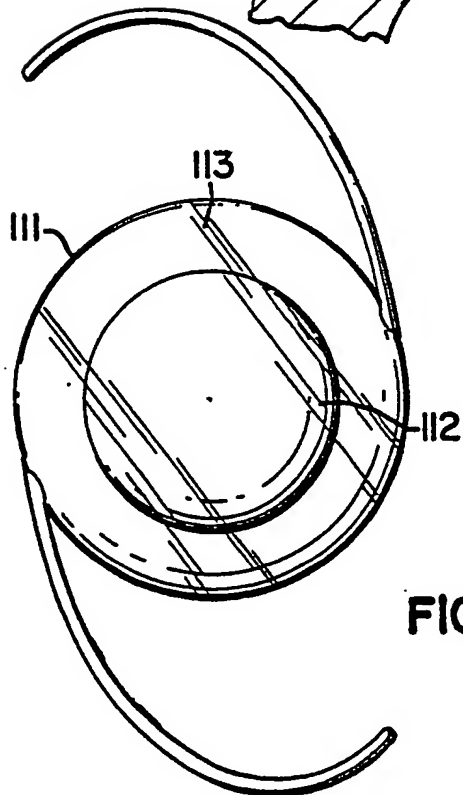


FIG.8

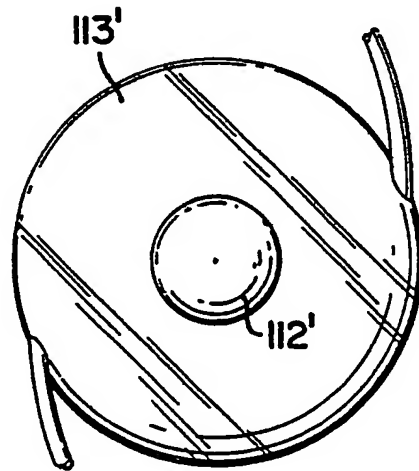
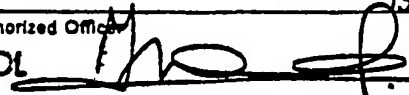


FIG.8A

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 87/01284

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|--|--|-------------------------------------|
| I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ | | |
| According to International Patent Classification (IPC) or to both National Classification and IPC | | |
| IPC ⁴ : A 61 F 2/16 | | |
| II. FIELDS SEARCHED | | |
| Minimum Documentation Searched ⁷ | | |
| Classification System | Classification Symbols | |
| IPC ⁴ | A 61 F | |
| Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸ | | |
| III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ | | |
| Category ¹⁰ | Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹² | Relevant to Claim No. ¹³ |
| X | EP, A, 0140063 (J. STROBEL) 8 May 1985, see figures 1-4; page 9, line 7 - page 10, line 24 -- | 1-23 |
| X | US, A, 4010496 (C.W. NEEFE) 8 March 1977, see figures 1-2; column 1, lines 47-57; claim 1 -- | 1,9-12 |
| X | FR, A, 2510768 (LYNELL MEDICAL TECHNOLOGY INC.) 4 February 1983, see page 23, lines 6-14 -- | 1,9-12 |
| P,X | US, A, 4636211 (NIELSEN et al.) 13 January 1987, see the whole document -- | 1-17 |
| P,X | WO, A, 86/03961 (A. VANNAS) 17 July 1986, see figures 3-7,12; abstract ----- | 1-23 |
| <p>¹⁰ Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> | | |
| IV. CERTIFICATION | | |
| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report | |
| 9th September 1987 | - 8 OCT 1987 | |
| International Searching Authority | Signature of Authorized Officer | |
| EUROPEAN PATENT OFFICE | M. VAN MOL  | |

INTERNATIONAL APPLICATION NO.

PCT/US 87/01284 (SA 17544)

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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| EP-A- 0140063 | 08/05/85 | DE-A- 3332313 JP-A- 60085744 | 04/04/85 15/05/85 |
| US-A- 4010496 | 08/03/77 | None | |
| FR-A- 2510768 | 04/02/83 | GB-A,B 2105866 DE-A- 3228352 JP-A- 58065412 US-A- 4402579 US-A- 4466858 CA-A- 1192069 US-A- 4450593 US-A- 4473434 | 30/03/83 31/03/83 19/04/83 06/09/83 21/08/84 20/08/85 29/05/84 25/09/84 |
| US-A- 4636211 | 13/01/87 | None | |
| WO-A- 8603961 | 17/07/86 | AU-A- 5315886 | 29/07/86 |

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